

Crop and Substrate Tests with Single Use Rooting “Pillows” for the VEGGIE Plant Growth Hardware

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VEGGIE Vegetable Production Unit

LED Light Cap

Teflon Bellows

Reservoir



Designed and built by Orbital Technologies Corporation (ORBITEC)

Initial Planting Tests

Planting directly over reservoir:

- Stunted growth
- Decline by 21 DAP
- Stem girdling/collapse due to nutrient toxicity
- Salt damage in roots
- Water logging in roots

Planting in blocks/plugs on reservoir:

- in 1 X Hoagland solution:
 - Poor germinations
 - Salt build-up on plugs
- In ½ X Hoagland solution:
 - Slow growth
 - Severe stunting
 - Wilting
 - Salt build-up

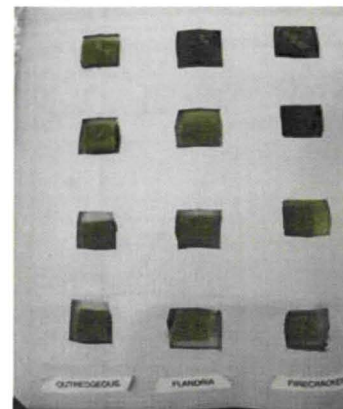
**One Layer Nitex
with 1X Hoagland**



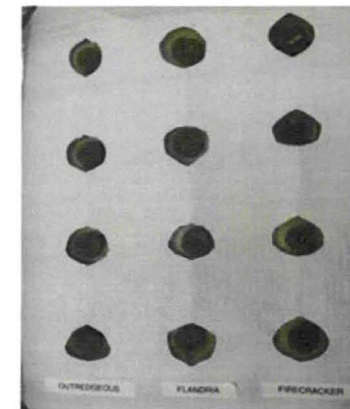
**Two Layer Nitex
with 1X Hoagland**



**Rockwool blocks at 7 DAP with
1X Hoagland**

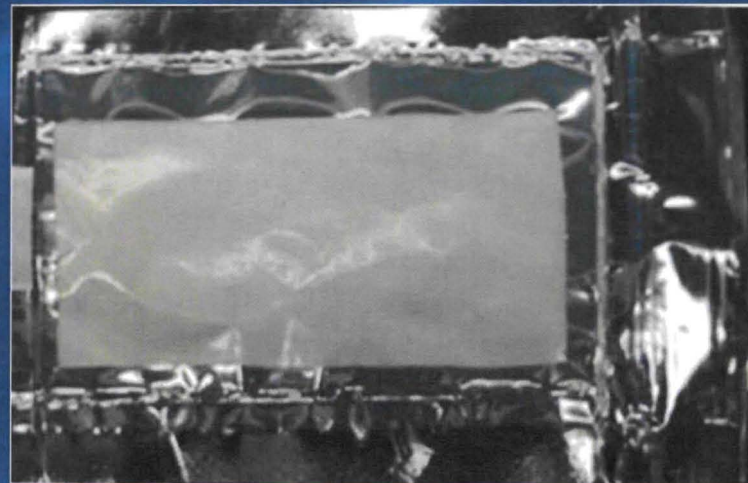
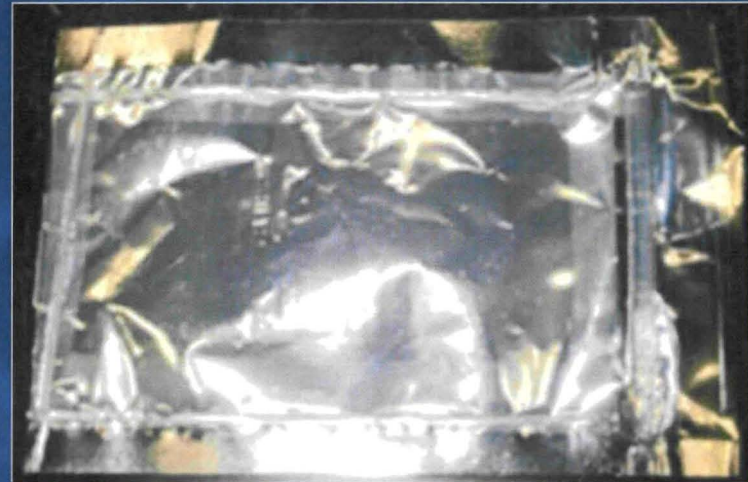


**Oasis Plugs at 7 DAP with 1X
Hoagland**



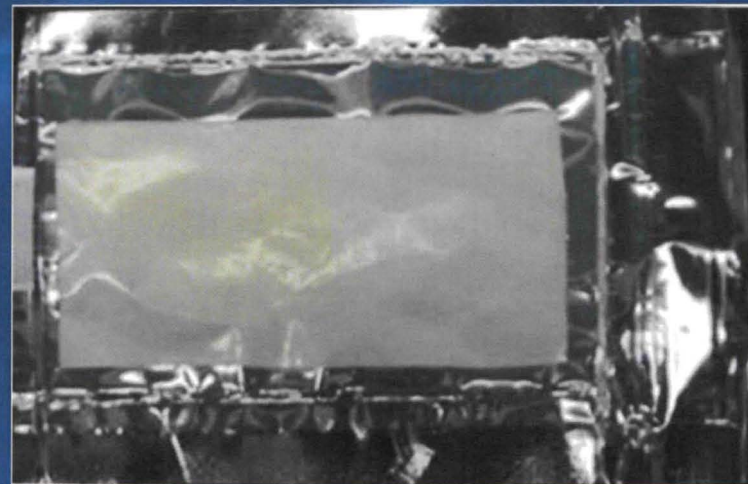
Pillow Concept

- Small bag
 - Resealable
 - Static shielding
- Wicking surface
 - Heat-welded Nitex (nylon) membrane
 - Allows passive wicking from reservoir
- Media Contained
 - Testing underway
- Fertilizer Contained
 - Time release
 - Nutricote 18-6-8 selected



Pillow Concept (cont.)

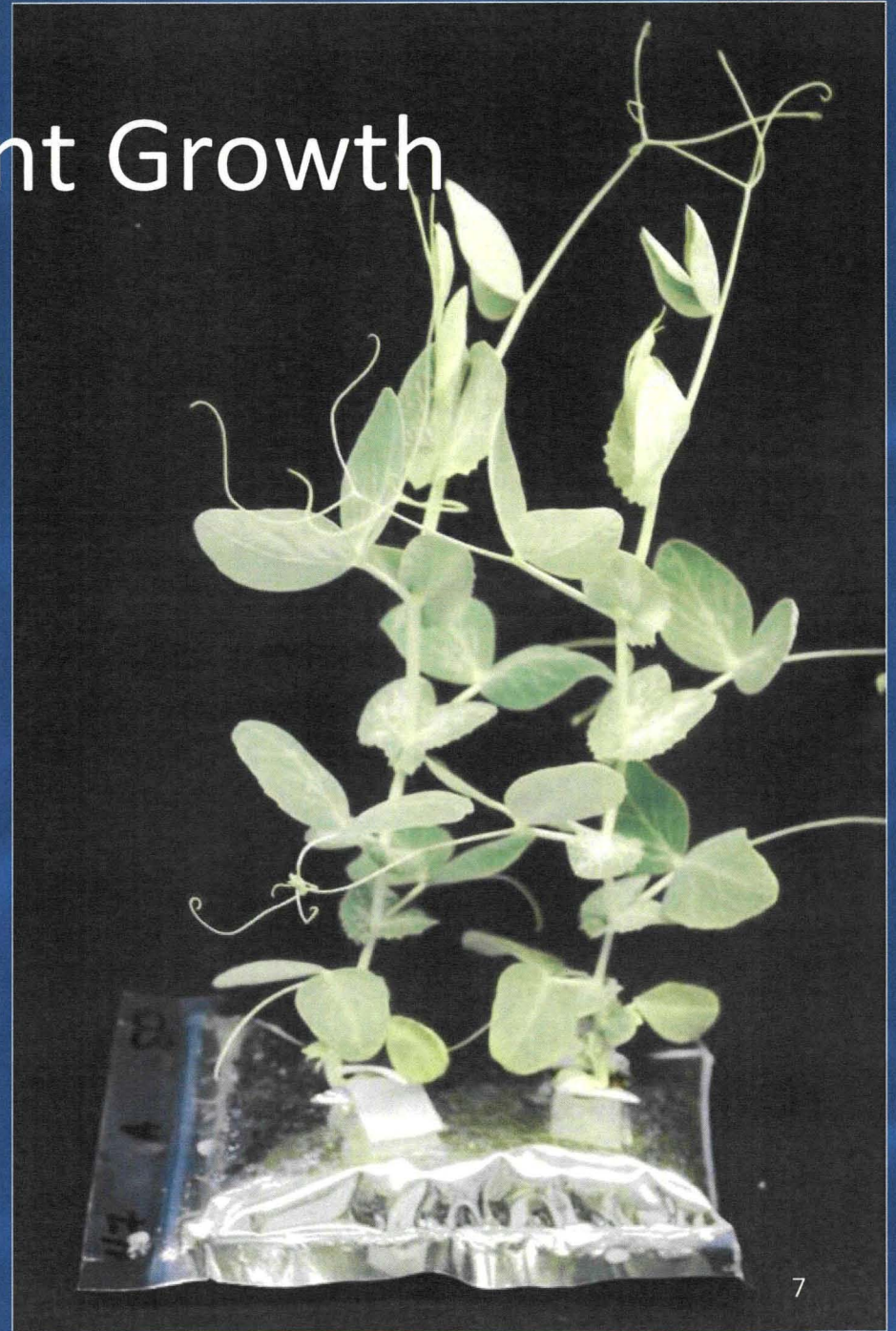
- Plant seeds dry, in 1 g
 - Low launch mass
- Hydrate on orbit
- No energy requirement
- Minimal crew time
- Designed for single use
- Dispose after harvest
- Reduces sanitation requirements



Pillow Testing in Reservoir Analog



Pillow Plant Growth



Early Media Studies



Relatively equal root growth and shoot yields in both peat-based and arcillite media

Media and Cultivar Test #1

13 cultivars

- 'Outredgeous' lettuce
- 'Flandria' lettuce
- Mizuna
- 'Sierra' lettuce
- 'Oak leaf' lettuce
- 'Tender leaf' Vegetable Amaranth
- 'Bright lights' Swiss Chard
- 'Tokyo Bekana' Cabbage
- 'Sugar Pod II ' Snow Peas
- 'Spicy Globe' Basil
- 'Genovese' basil
- Common Chives
- Greek Oregano

5 types of media

- Fafard # 2 (commercial peat-based media)
- Arcillite (1-2mm)
- 1:1 Fafard # 2 : Arcillite
- 7:3 Fafard # 2 : Arcillite
- 1:1 Perlite : Vermiculite

- Reservoir analogs
- Walk-in growth chamber
- Temp. and RH (28°C, 70%)
- 16 h photoperiod
- Elevated CO₂ – 1200 ppm
- Grown for 36 Days

Multiple Species and Cultivars



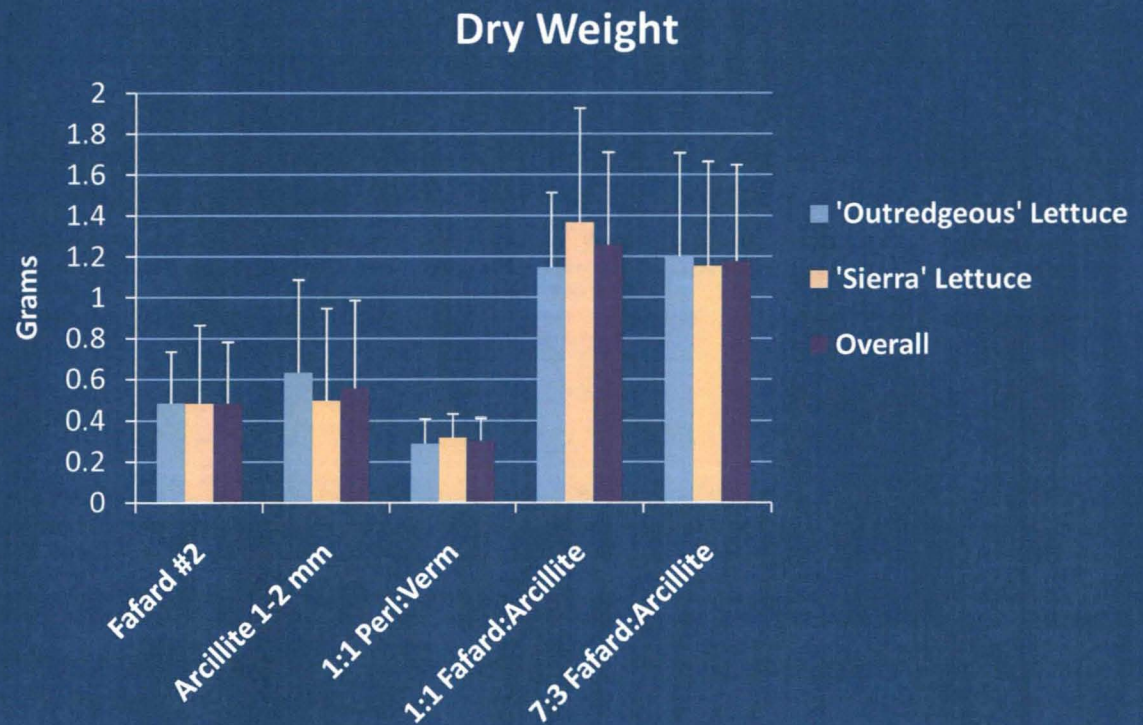
General Results – Cultivars and Media

Species/Cultivar Testing

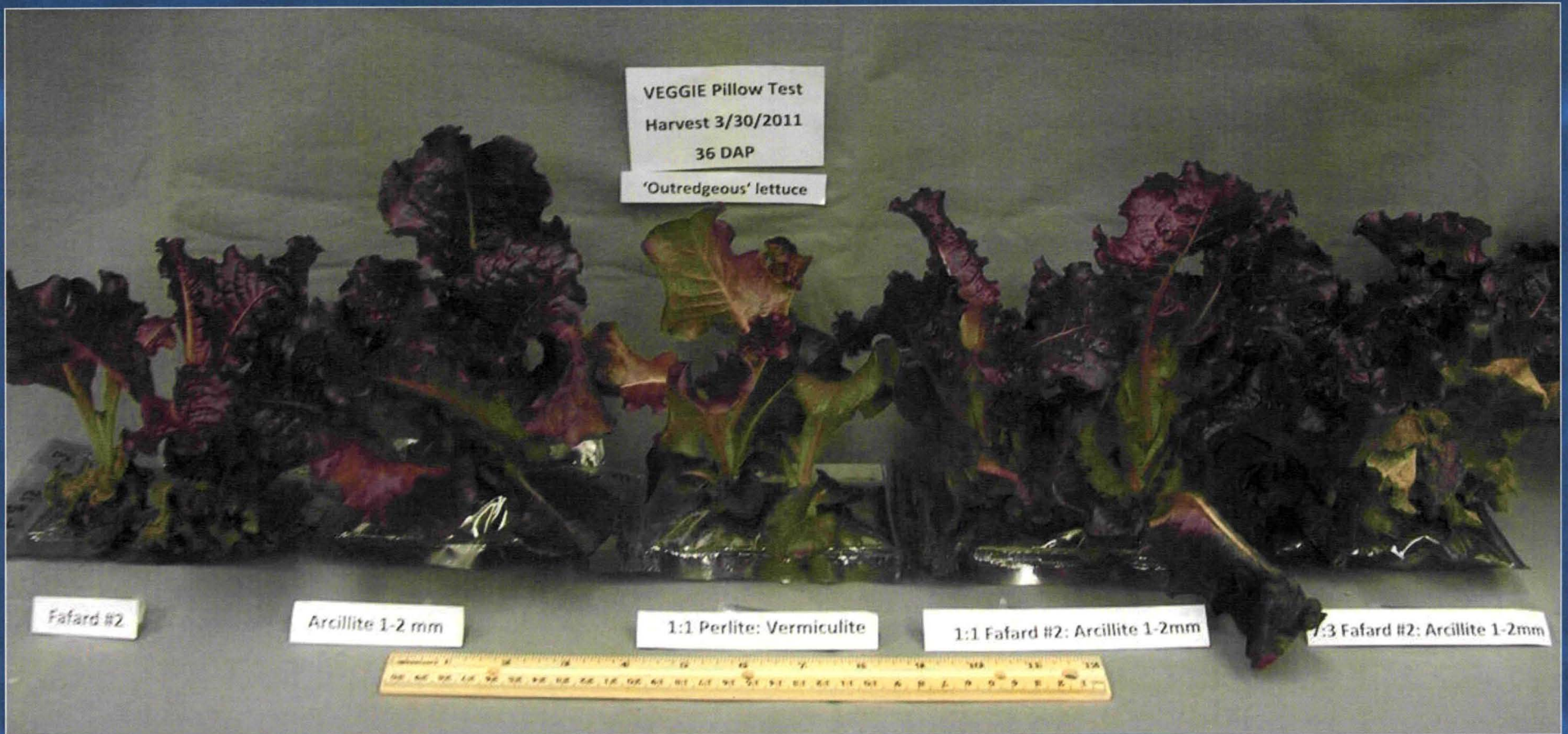
- Best performance in pillows seen from cultivars of:
 - Snow Pea
 - Lettuce
 - Chinese Cabbage
 - Mizuna
 - Swiss Chard
 - Basil

Media Testing

- 1:1 and 7:3 mixes support best growth



Different Media Types



Root Response Varies with Species and Media



Second Test

Cultivars

- 'Sugar Pod II' Snowpea
- 'Tokyo Bekana' Chinese Cabbage
- 'Bright Lights' Swiss Chard
- 'Outredgeous' Lettuce
- 'Cherry Bomb II' Radish

Media

- Fafard # 2 (commercial peat-based media)
- Arcillite (1-2mm)
- 1:1 Fafard # 2 : Arcillite
- 7:3 Fafard # 2 : Arcillite

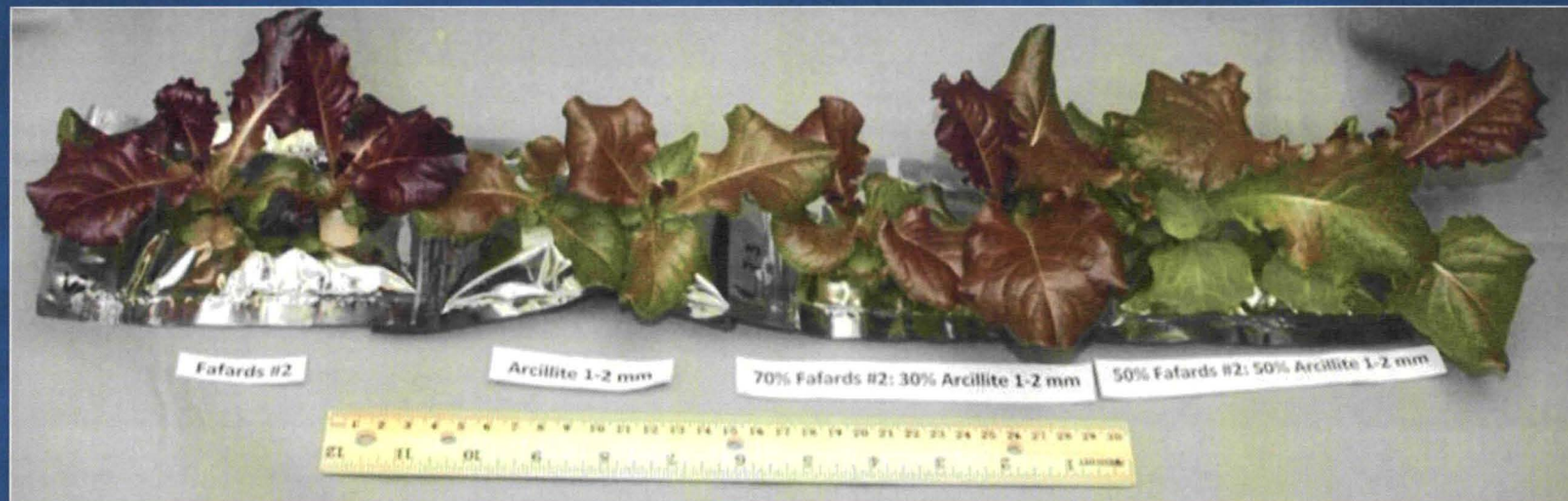
- Same environmental conditions
- All cultivars tested with all media
- Larger sample sizes
- Grown for 28 Days

Space Competition (28 DAP)

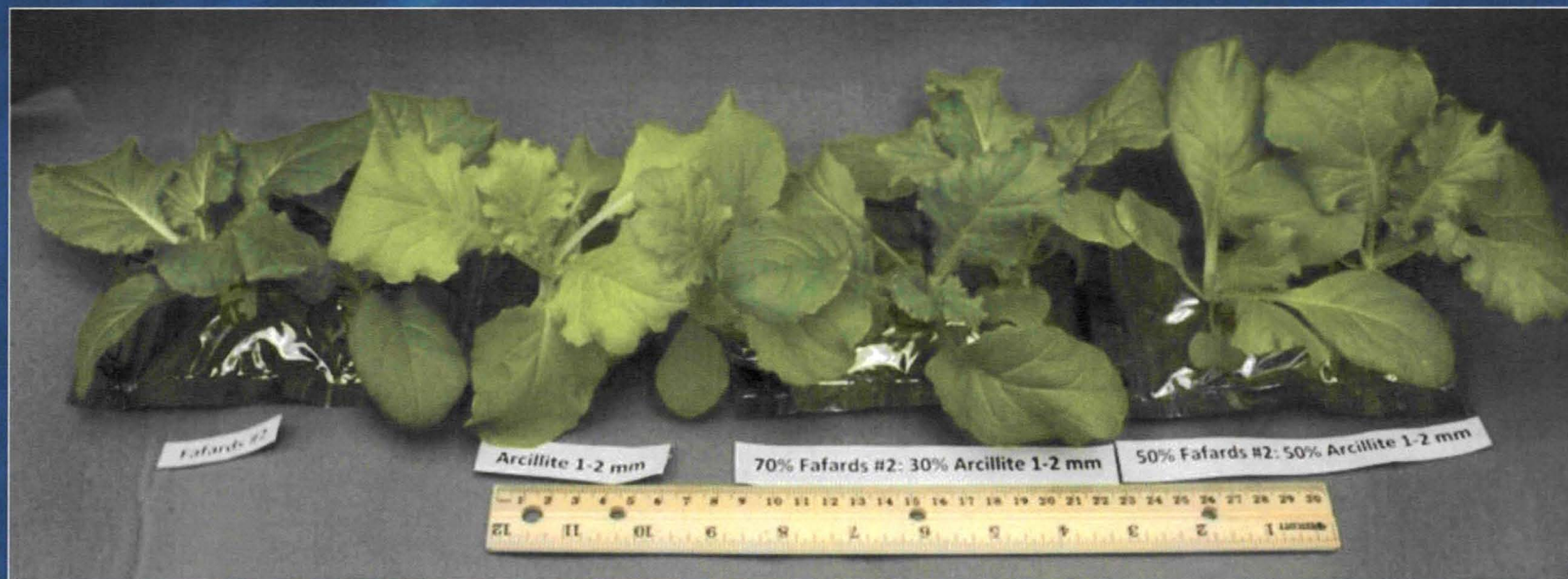


18 DAP

'Outredgeous' Lettuce



'Tokyo Bekana' Chinese Cabbage

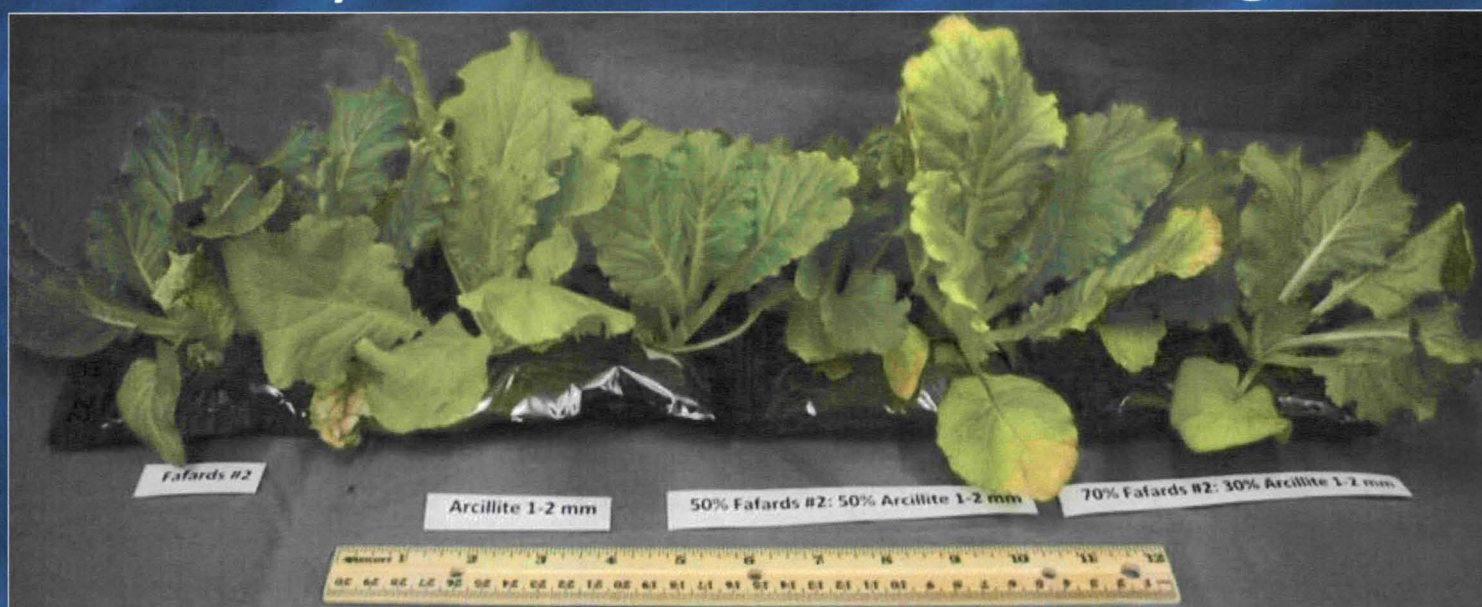


28 DAP

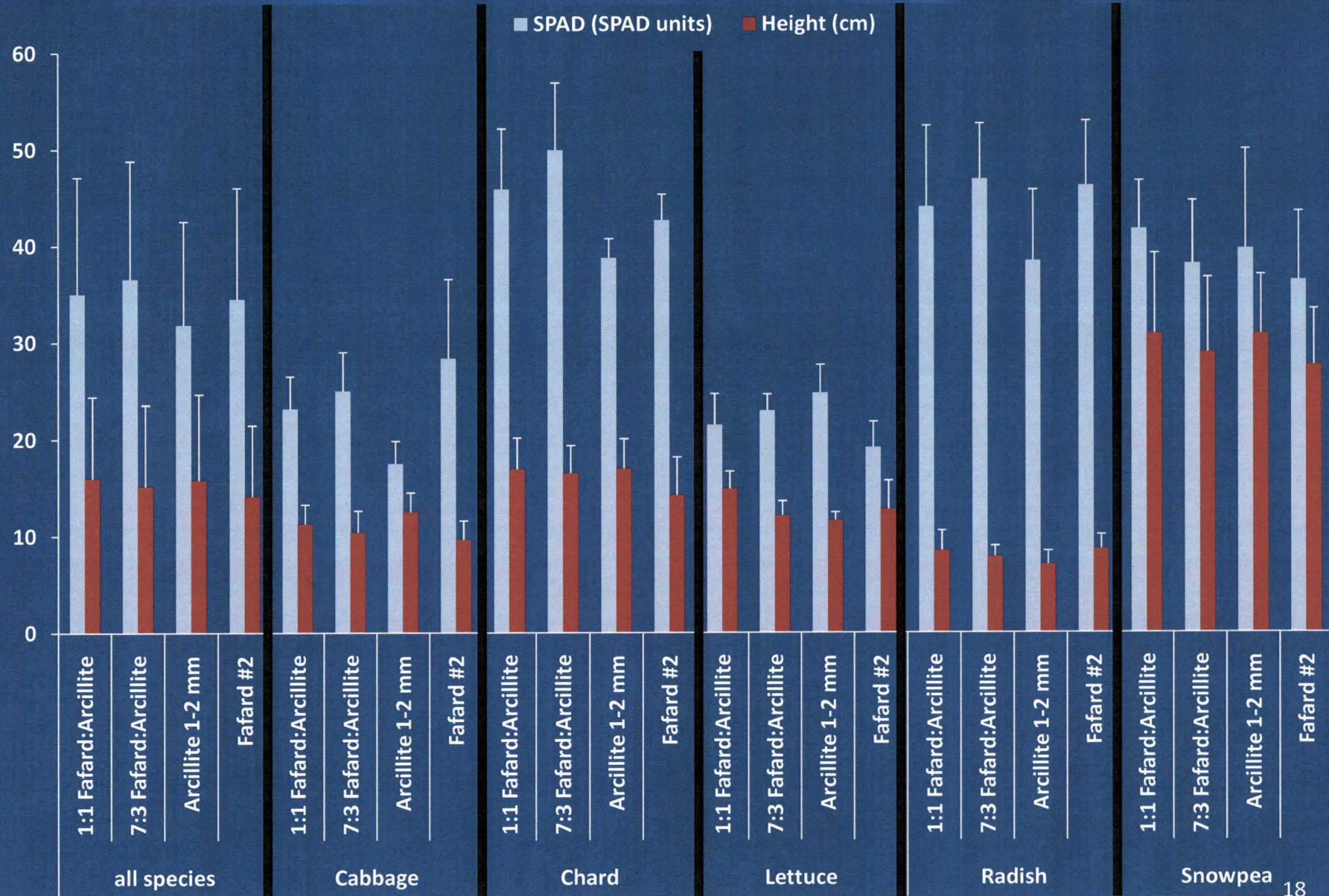
'Outredgeous' Lettuce



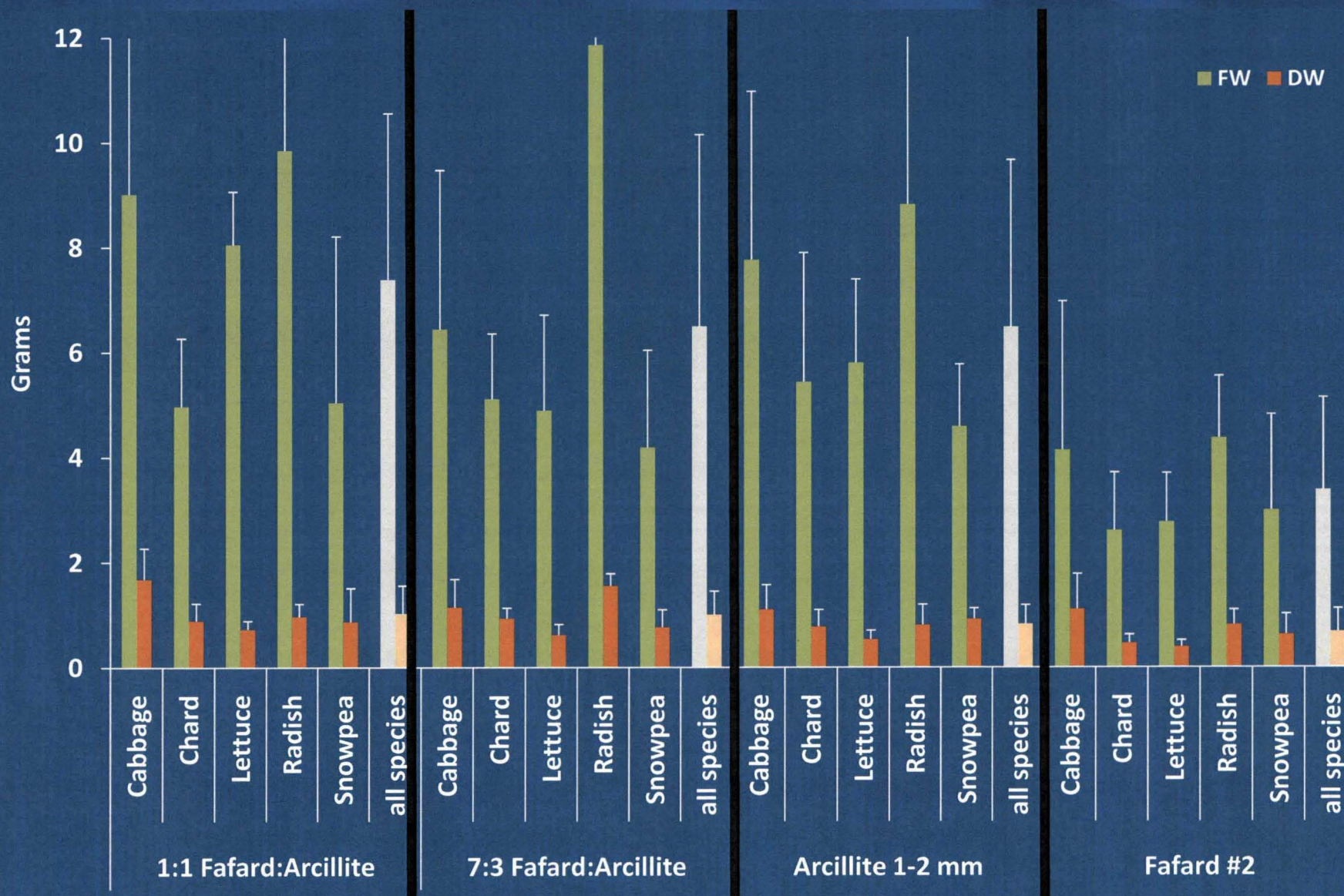
'Tokyo Bekana' Chinese Cabbage



SPAD and Height are cultivar-specific

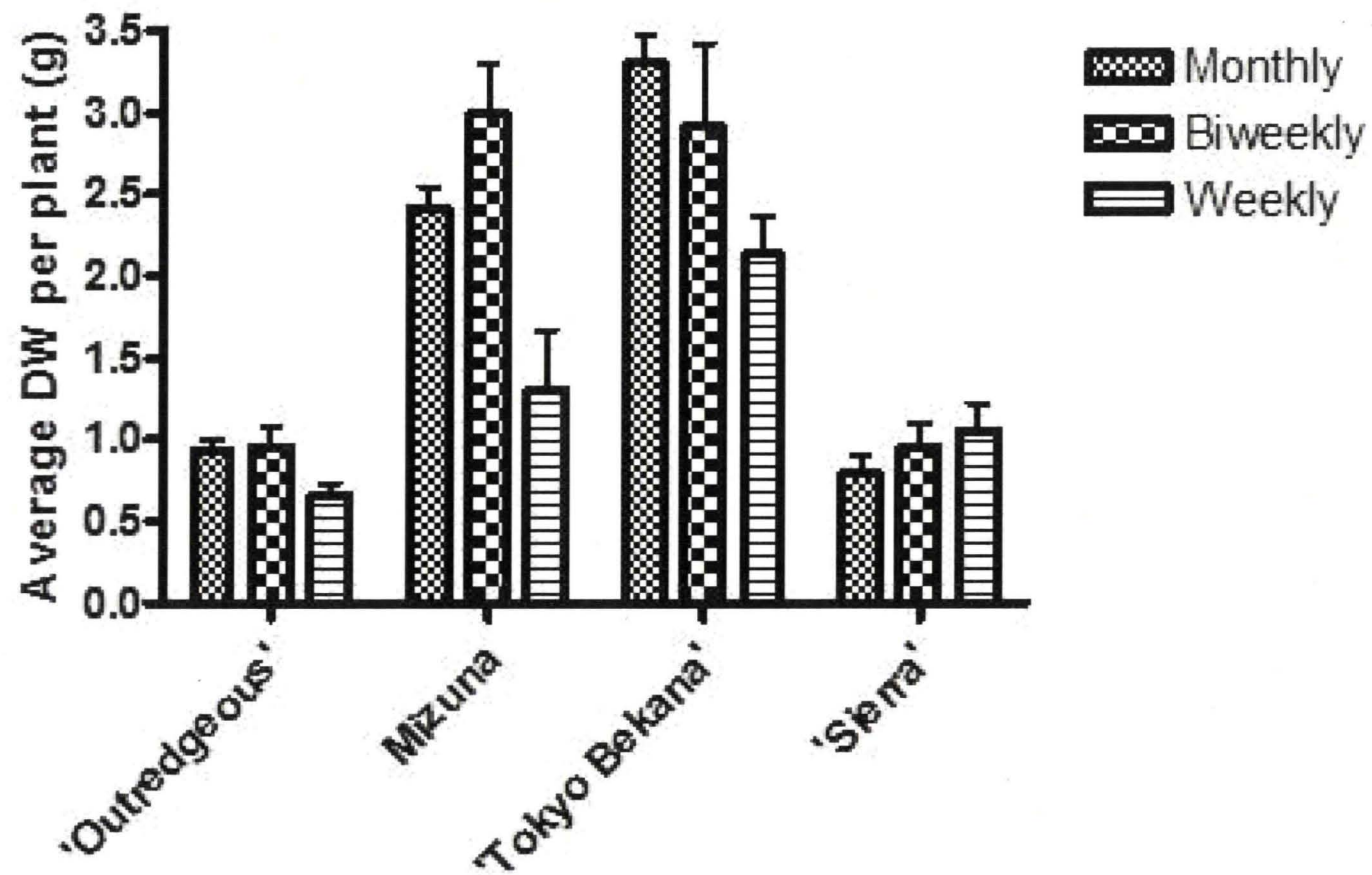


Effect of Media



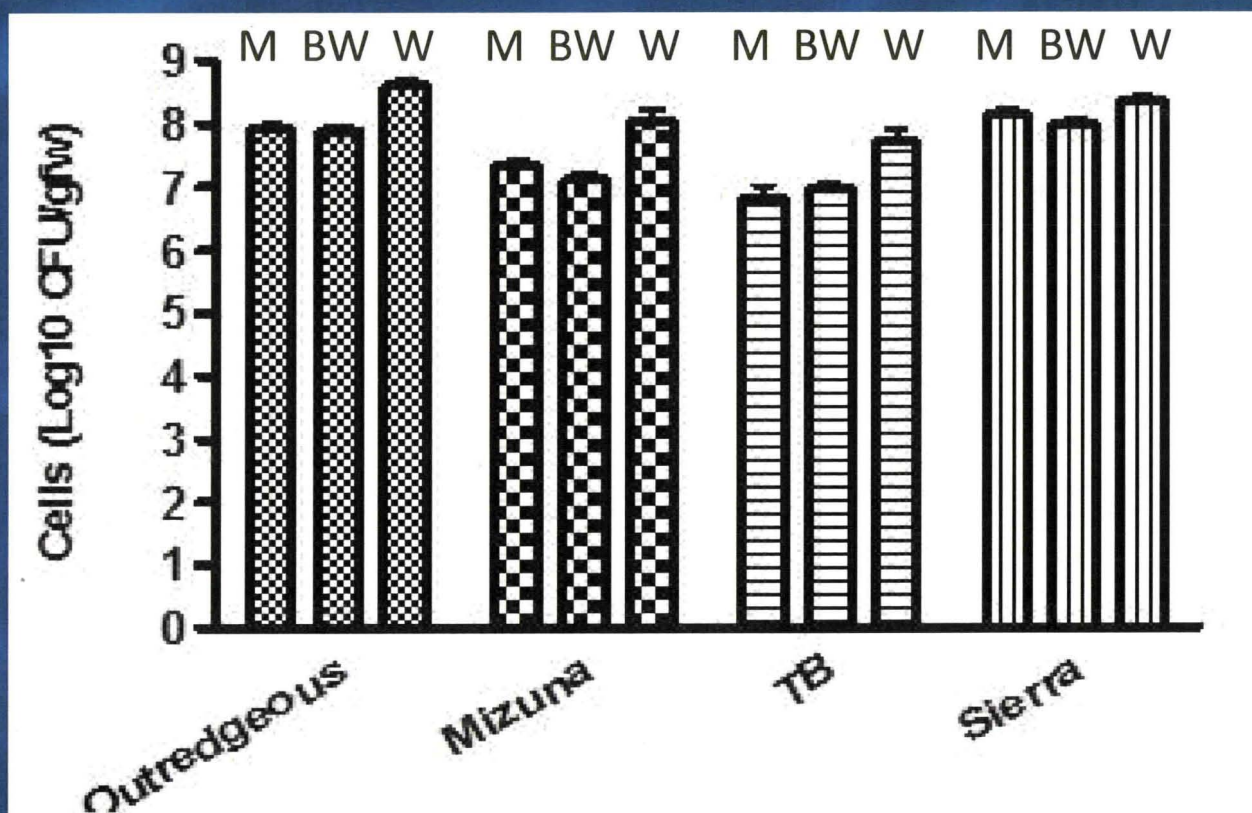
Next Steps

Harvest strategies



Next Steps

Harvest strategies and microbial load



Graph courtesy of Anthony Nguyen

Next Steps (cont.)

- Other media combinations
- Consideration of other factors:
 - Launch mass
 - Ease of rewetting
 - Uniformity
 - Storage
- Planting for microgravity

Media in Spaceflight – a few examples

- CHROMEX – Floro foam (Musgrave)
- PGBA – Agar and other media (Hohen)
- PTNDS – porous tubes (PT) - no media (Dreschel)
- SVET – Balkanine zeolite (Ivanova & Bingham)
- ASTROCULTURE- Arcillite with PT (Morrow)
- Balkanine-Arcillite comparison (Jones & Or)
- PESTO – Arcillite (1-2mm) with PT (Monje & Stutte)
- ORZS – multiple media, no plants (Bingham et al.)

Acknowledgements

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